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Oil crops and supply chain in Africa
La filière oléagineuse en Afrique

Dossier

Soybeans production in South Africa

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Abstract – Soybeans are a small but important and growing component of South Africa's agricultural economy. Large-scale production of soybeans did not begin until the late 1990s in South Africa, and area planted to soybeans has expanded rapidly. Rising yields supported by a favourable agricultural policy environment backing the commercialisation and use of agricultural biotechnologies, has facilitated a smooth transition of commercial farmers from the production of traditional grains to soybean production and to be able to rotate soybeans with other grain crops to maximise profits. Although soybeans are produced in nearly all the 9 provinces in South Africa, there is significant variation in output from one province to the other. Using data from the Department of Agriculture Fisheries and Forestry (DAFF), this paper examines the production efficiency of each province with respect to area under production, output and yield per hectare for the past 25 years. Despite the potential of the former homelands in soybean production, there is little progress owing to infrastructural problems and unfamiliarity with the crop. In order to improve production and consumption of soybeans in these areas of South Africa, it may help to set up soybean out-grower schemes, which will encourage smallholder farmers to pool their output and earn income from soybeans whilst learning the food value of the crop.

Keywords: Soybean / South Africa / production / yield / agricultural policy

Résumé – La production de soja en Afrique du Sud. Le soja représente une petite mais croissante composante de l'économie agricole de l'Afrique du Sud. La production à grande échelle de soja n'a pas commencé avant la fin des années 1990 en Afrique du Sud, mais les surfaces plantées en soja se sont ensuite étendues rapidement. L'augmentation des rendements du soja encouragée par une politique agricole favorable soutenant la commercialisation et l'utilisation des biotechnologies, a facilité une transition en douceur des agriculteurs de la production de céréales traditionnelles à la production de soja, introduit en rotation avec d'autres cultures de céréales pour maximiser les revenuss. Bien que le soja soit cultivé dans pratiquement chacune des 9 provinces d'Afrique du Sud, il existe une variabilité significative de la production d'une province à l'autre. En se basant sur les données du ministère Sud-Africain de la pêche, de l'agriculture et la forêt, cet article examine l'efficience de la production de soja de chaque province en fonction des surfaces en culture, et du rendement par hectare sur les vingt-cinq dernières années. Malheureusement, malgré le potentiel des anciens bantoustans [régions créées durant la période d'apartheid, réservées aux populations noires et qui jouissaient à des degrés divers d'une certaine autonomie] pour la production de soja, peu de progrès y sont réalisés en raison du manque d'infrastructures adaptées et de la méconnaissance de la culture. Afin d'améliorer la production et la consommation de soja dans ces zones d'Afrique du Sud, il pourrait être utile de mettre en place des programmes d'aides qui encourageraient les petits cultivateurs à regrouper leurs productions et à tirer des revenus du soja tout en les sensibilisant à la valeur nutritive des graines récoltées.

Mots clés : Soja / Afrique du Sud / production / rendement / politique agricole

1 Introduction

Soybeans (*Glycine max*) are a small but important and growing component of South Africa's agricultural economy (de Beer and Prinsloo, 2013). The budding importance of soybean in South Africa is demonstrated by the area that has been set aside for, or brought into production of, the crop in recent years. Rising yields supported by a favourable agricultural policy[1] environment backing the commercialisation and use of

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[1] For example, the GMO Act of 1997 provides for the development and use of transgenic crops in South Africa amidst strong resistance of such technologies in other countries in the region, notably Zimbabwe.

agricultural biotechnologies, has facilitated a smooth transition of commercial farmers from the production of traditional grains to soybean production and to be able to rotate soybeans with other grain crops to maximise profits. For example, Van der Merwe *et al.* (2013) contend that the increase in production is ascribed to commercial farmers becoming cognisant of the benefits of soybean in crop rotation systems with maize. The government of South Africa recognises the importance of soybeans in the economy. The Industrial Policy and Action Plan (IPAP) 2012/13 – 2014/15 distinguishes soybeans as having the potential for creating opportunities for new investments and job creation (Dti, 2010). To that extent, the Department of Trade and Industry (Dti, 2010) has initiated elaborate processes that will culminate in investments that will lead in the development of new soybean processing plants and improvements in existing processing facilities during the 2012/13 to 2014/15 financial years. These policy directives have elevated soybeans as both a cash and food crop. In the process multinational seed companies have been enticed to develop improved soybean seed varieties that can perform in a wide spectrum of localities or that are locality specific, year after year (de Beer, 2012).

The fruits of this favourable agricultural policy environment have made it possible for soybean farmers to produce increasingly high yields of soybeans year after year since 1997/8. As a result, the South African Bureau for Food and Agricultural policy (BFAP, 2013) projects that there would be an increase in the amount of land set aside for commercial soybean production in the next ten years in South Africa. Encouraged by an intensified focus on soybean as an important crop for human nutrition and an ever-increasing local industrial demand for soybeans for agro processing (Dti, 2010), it is no wonder that the production of soybeans has become so appealing to South African farmers in recent years. A combination of high yields per hectare in soybean farms (especially in the foremost soybean producing areas) together with favourable soybean prices has caused gross incomes per hectare for soybean producers to improve significantly (BFAP, 2013). As well, South African soybean prices have improved favourably to match export parity levels, – and are expected to surpass them in the next three to four years–, whereas soybean derivatives, soymeal cake and oil, prices have gradually moved closer to import parity levels (BFAP, 2013). These developments have improved the economics of oilseed crushing – making soybean crushing economically attractive – in South Africa. In turn, private investments which are geared towards increasing soybean crushing capacity in South Africa (BFAP, 2013) have also trickled in. Subsequently, more farmers in South Africa are expected to switch to soybean production both in the short and long term (BEAP, 2013; Dti, 2010).

Moreover, in spite of the bright outlook that the production of the crop evidently has, not all the provinces in South Africa are suitable for soybean production. This paper analyses the production of soybeans in the different provinces of South Africa. It aims to show which province has driven soybean output in an attempt to contextualise production with agro-ecological suitability of the different provinces. In so doing, the paper seeks to identify areas that have a potential for soybean production using production data that covers the period 1987 to 2012. The paper starts with a discussion of the historical developments that laid the foundation for soybean production in South Africa. This is followed by a discussion of soybean utilisation in South Africa and an analysis of soybean production at provincial level. The final part of the paper draws some conclusions.

2 The evolving importance of soybeans in South Africa

Soybeans were first introduced into South Africa in 1903 (du Toit, 1942). However, at the time, South African farmers had very little or no information about the crop which subsequently stalled its production (du Toit, 1942). By and large, farmers experienced a lot of production side difficulties. The then Department of Agriculture and Forestry worked determinedly to minimise these difficulties through several initiatives which were geared towards developing an understanding of soybean production opportunities in South Africa (du Toit, 1942). The focus was on how reoccurring production difficulties could be eradicated by finding advanced soybean production methods. Writing in 1930, Hall recommended that the crop should be grown in the Natal region (present day KwaZulu Natal Province), arguing that when properly managed; it could produce hay of considerable feeding value for livestock.

Notable bodies that were significant in kick-starting the soybean industry in South Africa include the feed Committee which was instituted in 1942 to exclusively look into matters pertaining to animal feed and its improvement (Viljoen, 1944); the Department of Agriculture and Forestry; the oil expressers association; and the Animal Feed Manufacturers association (AFMA). Traditionally, South Africa has always been, and continues to be, a net importer of soybeans (NAMC, 2011; IPAP, 2010). For example, as a consequent of high demand against low production in the 1940s, about 75 per cent of South Africa's protein crops were imported from other countries, mainly Europe and the USA of which soybeans were amongst them (Viljoen, 1944). However, concerns about limited shipping capacity motivated the Oil Expressers' Association to sponsor the creation of AFMA "to undertake and facilitate the importation and distribution of protein-rich feeds" (Viljoen, 1944) in South Africa. In 1943, the South African protein pool made arrangements to dispense imported protein crops to animal feed manufacturers based on their production of mixtures (PRF, 2013). Notwithstanding, the demand for protein crops continued to be above their supply primarily because of under production locally. This invigorated further research that sought to understand the production possibilities of protein crops, especially soybeans, in South Africa.

However, it was not up until the late 1990s that the production of soybeans started to gain momentum. Previously, output hovered below 50 000 tonnes nationwide with land under production below 50 000 hectares, as shown in Figure 4. In the meantime and given its changing strategic importance first as a key protein source in the manufacture of animal feed and at the present as both a key commodity for human and animal nutrition, soybeans had gradually moved into the heart of South

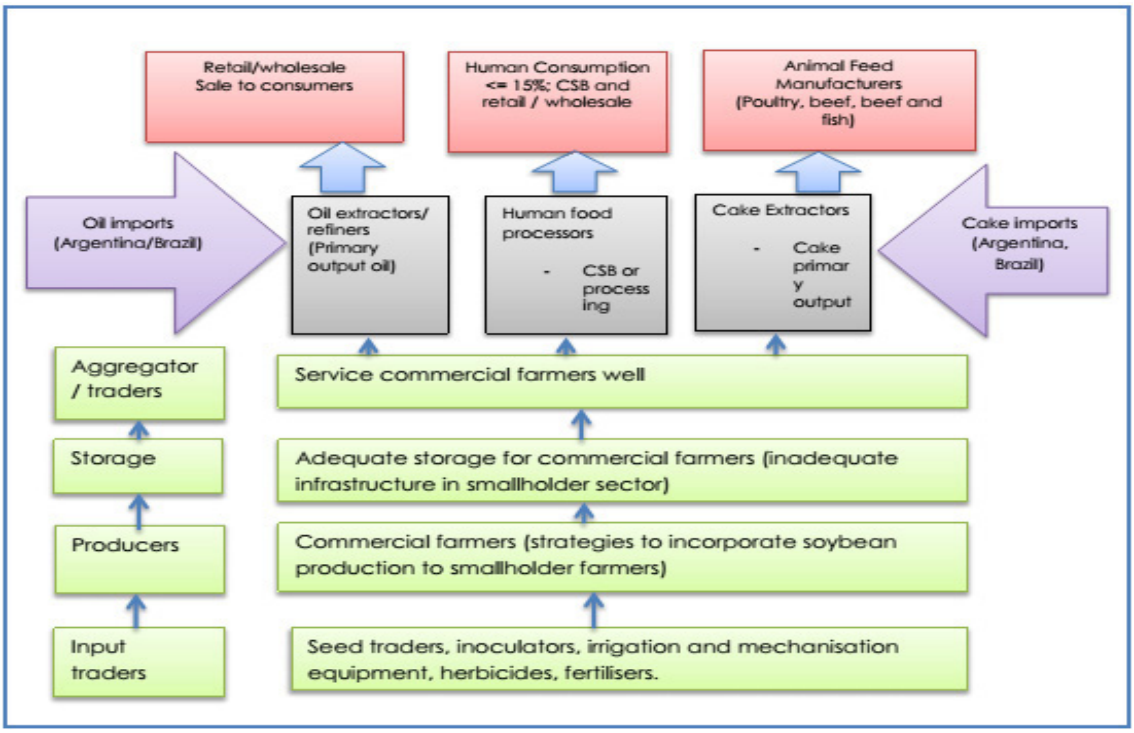

Fig. 1. Soybean value chain in South Africa. *CSB = corn soya blend. Adapted from Opperman and Varia (2011), using data from NAMC (2011).

African agriculture, earning a space in the country's industrial policy action plan (IPAP) in 2010.

2.1 The South African soybean value chain

The soybean value chain in South Africa is made up of input suppliers (seed, fertilisers, herbicides, insecticides, inoculants, mechanisation and irrigation equipment), producers (mainly commercial farmers), aggregators and traders (ensure that there is a ready market for soybean produce and that processors have reliable supply for their inputs), processors (process raw soybeans into meal, oil or soybean based foods for human consumption) feed manufacturers (use soybean meal produced by processors as an input for animal feed mainly poultry), as well as beef, pork and fish industries, as shown in Figure 1. In between the wholesalers and storage providers, there are soybean imports which mainly come from Argentina and Brazil (NAMC, 2011). Currently, local production meets only 10% of the domestic soybean meal demand (NAMC, 2011). On average, 90% of soymeal consumed in South Africa is imported from Argentina whereas 94% of soybean oil comes from Brazil and Argentina (NAMC, 2011). The National Agricultural Marketing Council (NAMC) documents that soymeal imports increased by 9% annually from 2005 to 2010, whereas local production of soymeal increased by 20% annually during the same period – illustrating a growing local capacity to process soybeans.

The growth of any crop production enterprise is also dependent on the availability of good quality seed. The seed industry is regulated under the Plant Improvement Act, 1976 (Act No. 53 of 1976) to ensure orderly trade in seed. This Act makes provision for the registration of premises from which the sale, cleaning and packing of seed may be undertaken and to prescribe the conditions subject to which seed may be sold. Included in the Act is provision for the establishment of certification and other schemes and it also provides for the designation of the authority that shall exercise the powers, perform the functions and carry out the duties conferred upon them. South Africa exports seeds for soybeans to other African countries such as Angola, DRC, Kenya, Malawi, Mozambique, Senegal, Sudan, Tanzania, Zambia, and Zimbabwe; Asia (Pakistan, Turkey); South America (Argentina, Uruguay) and Europe (France). A greater proportion of the seed, however, is sold to neighbouring countries. The seed industry imports seed from countries such as the USA, Europe (Denmark, Germany, and Netherlands), Japan, Australia and New Zealand, as well as South America (Uruguay) (SANSOR, 2013).

The soybean seed market in South Africa has been growing in the past 10 years. According to information supplied by SANSOR, the local soybean seed market was R3.6 million (roughly US$360 thousand) in 2004/05. Of this, 52% was through the sales of Genetically Modified Organism (GMO) seed. The proportion of farm saved seed as a percentage of the potential local seed market was 65% in 2004/05 and 85% in 2007/08. In 2011/12, GMO sales as a fraction of local seed market had increased quite substantially. Whereas in 2004/05 they stood at 52%, in 2010/11, 98% of soybean seed sold in South Africa were transgenic, as shown in Table 1. Interestingly, from 2004/05 up until 2007/08 farm saved seed as a percentage of potential local soybean seed market has also been increasing. According to the NAMC, about 75%

Table 1. Seed market in South Africa: 2004/5–2012/13.

Soybean	Local market (ZAR'000)*	Export market (ZAR'000)*	Market value based on retail selling price ('million)	GMO sales (ZAR'000)*	Farm saved (% of potential market)	GMO sales as a fraction of local market
2004/05	3 635.40	–	31.61	1 890.41	65	52%
2005/06	1 801.46	11.20	19.36	1 495.21	78	83%
2006/07	2 737.26	141.68	22.32	2 326.67	85	85%
2007/08	1 675.22	8.68	18.36	1 306.67	85	78%
2008/09	3 369.12	97.78	45.53	2 975.14		88%
2009/10	4 227.52	113.89	72.75	4 102.51		97%
2010/11	4 729.76	93.55	78.64	4 635.42		98%
2011/12	4 358.63	8.40	52.19	3 923.84		90%
2012/13	5 789.32	226.30	127.49	2 835.28		49%

*ZAR = South African rand: 1R = ~€ 0.1. Source: SANSOR, 2005–2013.

of commercial farmers use recycled soybean seed in South Africa, and amongst key players is Pannar, Pioneer Seed and Link Seed. Inoculants also play a major role in the production of soybeans in South Africa given that local soils exhibit serious shortages of nitrogen fixing bacteria (NAMC, 2011). The key players in supplying inoculants are stimulant and soy grower (NAMC, 2011).

More than 80% of soybean purchased seeds are Roundup Ready cultivars (DAFF, 2010). However, in as much as there is a high usage of transgenic seeds, South African farmers also use a lot of conventional seed, probably to capture the lucrative UNICEF/WFP CSB market which often demands non-GMO soybeans. About 40% of land under soy production uses fertiliser and dominating suppliers of fertiliser include Foskor (pty), Omnia Fertiliser, Sasol Nitro, Yara SA (Pty) and Profert (NAMC, 2011). In terms of herbicides and pesticides, Syngenta South Africa and Efkto are the main players in the sector (NAMC, 2011).

2.2 Soybean utilisation in South Africa

Even though soybeans have incredible nutritional qualities, they form a very small percentage of the average household's diet in South Africa (Joubert and Jooste, 2013; Dti, 2010; DAFF, 2010). The primary uses of soybeans include soybean oil, soybean cake (full fat cake and low fat cake) and soybean products for human consumption, with the latter being relatively low (Opperman and Varia). Currently, assessments by the DAFF (2010) reveal that soybeans are largely consumed by the livestock sector. Soybean consumption for oil and protein is at 25%, whilst 60% is for animal feed. The poultry industry is by far the largest consumer of soybean derived proteins (Joubert and Jooste, 2013) in South Africa. A meagre 15% is used for human consumption. South Africans consume soybeans through a variety of over the counter food stuffs such as soya sources, soups, and other nutritious breakfast foods such as yogurt and flavoured soymilk products. Although direct consumption remains relatively very low, in some instances, consumers also use soymilk which is consumed by people who are lactose intolerant, which generally exclude the poor. Corn soya blend (CSB) ranks highly as a food source for human consumption especially for vulnerable groupings such as children, breast-feeding women, underground mine workers and the infirm. According to Opperman and Varia (2011) the Republic of South Africa produced about 600 tons of CSB monthly in 2010. CSB is comprised of 75% maize, 24% extruded soybean and vitamins. The sales of CSB are driven by UNICEF and World Food Programme (WFP) and often must comply with the local regulations on GMO. Even though in other countries, such as Zambia (which boasts 3 operations of CSB), Malawi (4), Zimbabwe (1) and Mozambique (1) (Opperman and Varia, 2011), GMO are currently not allowed in these countries, hence much of the soybeans used are GMO free. However, since GMO are allowed in South Africa, it is possible that the CSB produced for local consumption contains GMO soybeans and maize.

2.2.1 Getting soybeans into South African households

The South African government has made provisions for funding initiatives geared toward developing a programme for integrating soybeans into existing food products in South Africa (IPAP, 2010). In addition, there are efforts to bring in more land into the soybeans production for human consumption (DAFF, 2013). A bulk of this land will most probably come from the former homelands where there are large tracts of land that are currently being underutilised. This is expected to culminate in the development of new soybean-based food products, which should ideally go a long way in sensitising South Africans about the food value of soybeans, and thus expand soybean consumption in both rural and urban households. The government's efforts to increase soybean production amongst smallholder farmers is based on the fact that all production efforts and policy tools accorded soybeans in the past were meant to increase soybean output for the manufacture of soymeal which in turn is used as a protein source in the manufacture of animal feed, as well as oil for human consumption. To that extent, the former homelands in South Africa are producing, by and large, very small quantities of soybeans in contrast to the suitability of the environment for the production of the crop. Figure 2 shows that some parts of the Eastern Cape Province, for example, have a high potential for soybean production. However, actual production data reveals that soybeans production in the Eastern Cape is not as vibrant as it should be.

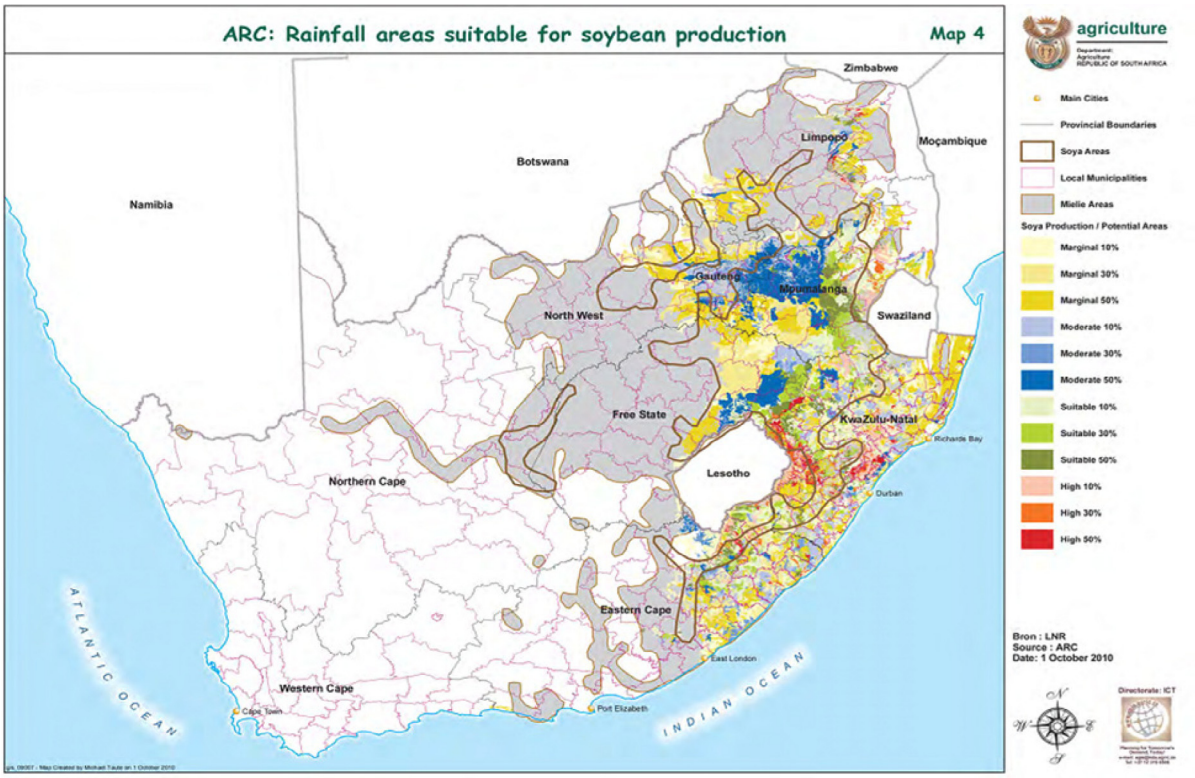

Fig. 2. Rainfall areas suitable for soybean production in South Africa. Source: Blignaut and Taute (2010).

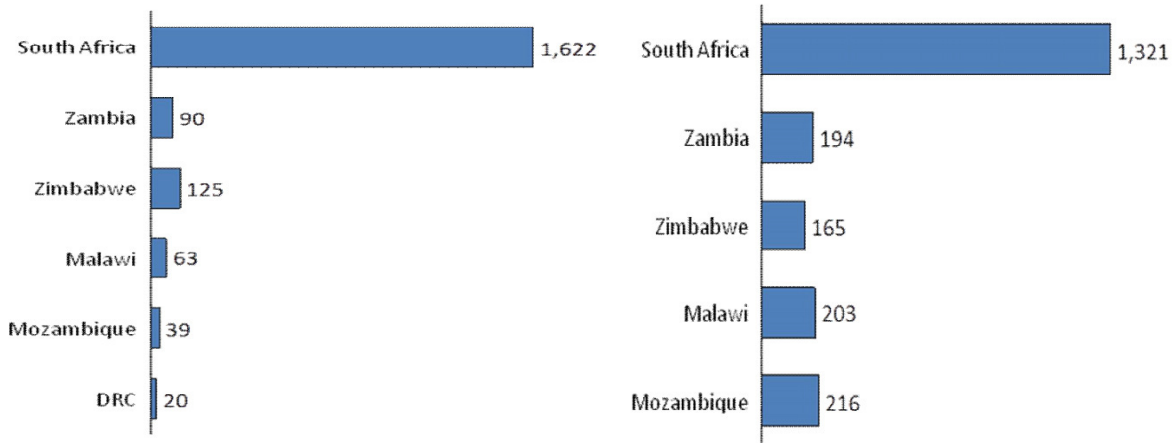

Fig. 3. Demand for soybean oil (left – panel (a)) and soycake meal (right – panel (b)) in Tons ('000 tons) in selected Southern African development community (SADC) countries – 2010. Source: Opperman and Varia (2011).

One reason for this is that in South Africa, subsistence farmers consider soybeans a commercial crop and thus are seldom produced nor consumed the crop directly by rural households.

According to Opperman and Varia (2011), the demand for soybean is well established in South Africa and throughout the Southern Africa Development Community (SADC). Demand is mainly for soybean oil which was at 1.3 million tons in 2010 for South Africa. Other countries in the region such as Malawi, Mozambique, Zimbabwe and Zambia follow South Africa with a demand of about 0.2 million tons of soybean oil each, in 2010. Opperman and Varia (2011) attribute this to the dominance of the South African economy in the region as the main factor behind South Africa having a higher demand, than her neighbours. Interestingly is that, soybean oil is perceived as an inexpensive alternative to sunflower oil in South Africa (Opperman and Varia, 2011). Generally, South Africa has a higher demand for soycake meal than any of the SADC countries, which stood at 0.3 million tons higher than other SADC countries, namely Zimbabwe, Malawi and Zambia, as shown in Figure 3, panels a and b, in 2010. South Africa

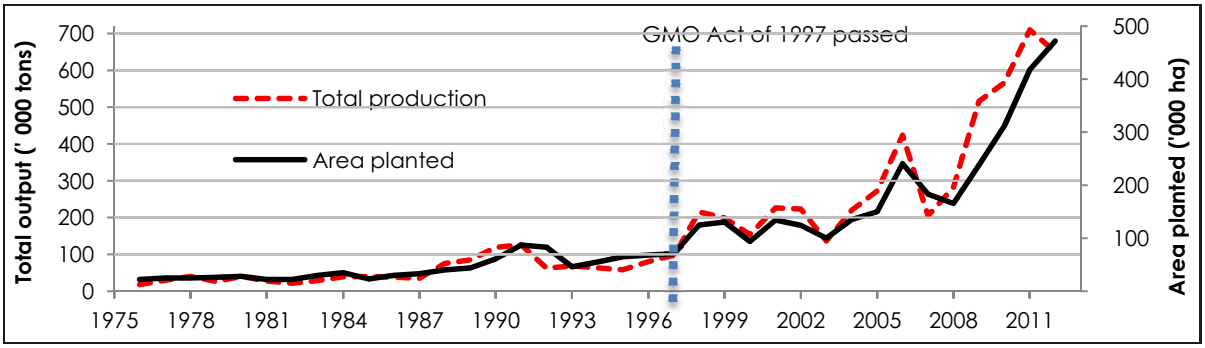

Fig. 4. Soybean area under production and output in South Africa (1988–2012). Source: Author's own calculation using data from the department of agriculture fisheries and forestry (DAFF).

Table 2. Soybeans in South Africa: area planted, production and yield.

	Area planted			Total production			
Production year (x)	Area planted (ha)	Compound annual growth rate (CAGR) of area planted(%) (1976 and x)	(1997 and x)	Tons	Average yield/ha	Compound annual growth rate (CAGR) of output (%) (1976 and x)	(1997 and x)
1976	22 000.00			17 900.00	0.81		
1980	28 000.00	6.2		39 900.00	1.43	22	
1985	23 000.00	0.5		39 900.00	1.73	9	
1990	61 000.00	7.6		119 000.00	1.95	14	
1993	45 999.56	4.4		68 600.00	1.49	8	
1994	55 000.00	5.2		63 100.00	1.15	11	
1997	71 000.00	5.7		98 000.00	1.34	8	
2000	93 790.00	5.7	9.4	153 925.00	1.64	9	16.2
2005	150 000.00	6.8	9.8	272 500.00	1.82	10	13.6
2012	472 000.00	8.9	10.5	650 000.00	1.38	10	15.9

Source: Author's calculations, based on data from the Crop estimation committee, Department of agriculture, fisheries and forestry (DAFF) (2013).

is also expected to continue dominating demand for soybean derivatives in Southern Africa in the future (Opperman and Varia, 2011).

3 Soybean production in South Africa

Following the ground breaking study of Hall (1930), who offered that "soybeans can be grown in those parts of Natal [KZN] having a good rainfall", a lot of progress has been made in understanding the cultivation; production and processing of soybeans in South Africa. In addition to Hall's (1930) study, nowadays soybeans are produced nearly in all the provinces in South Africa, albeit with varying magnitudes. The area planted to soybeans has also increased quite considerably ever since then. Figure 4 shows the area planted to soybeans in hectares and the total output produced in tons, whilst Map 1 contextualises these areas with rainfall suitability for soybean production. In 1976, for example, 22 000 ha were planted to soybeans. This gave an output of 17 900 tons with an average yield of 0.814 t/ha, which was many tons lower than the country's demand of about 120 000 tons in the same year (PRF, 2013). In 1993, soybeans output stood at 63 100 tons with an average yield of 1.49 t/ha. The land under production had, however, decreased to 45,999 ha compared to 61 000 ha in 1990. Following the enacting of the GMO Act of 1997, the land under soybean production increased substantially. Between 1997/8 and 2012, land set aside for soybeans increased from 93 790 ha to 472 000 ha. The Compound Annual Growth Rate (CAGR) of the area planted to soybeans from 1997 to 2012 was 10.5% contrasted with a CAGR of 8.9% if 1976 is used as the base year, as shown in Table 2. This suggests that due to an increase in the supply of quality transgenic seed – although there is still a high usage of farm saved seeds–; farmers have been able to expand the area under production (BFAP, 2013).

The CAGR for output for the period beginning from 1997 to 2012 is 15.9%. Moreover, it becomes clear when the CAGR of output is compared with the CAGR of area planted that yields per hectare have improved quite significantly in South Africa in the past 16 years. Whereas the CAGR for area planted grew by between 9.4% and 9.8% for the periods 1997 to 2000 and 1997 to 2005, respectively, the CAGR for total output was 16.2% and 13.6%, respectively, for the

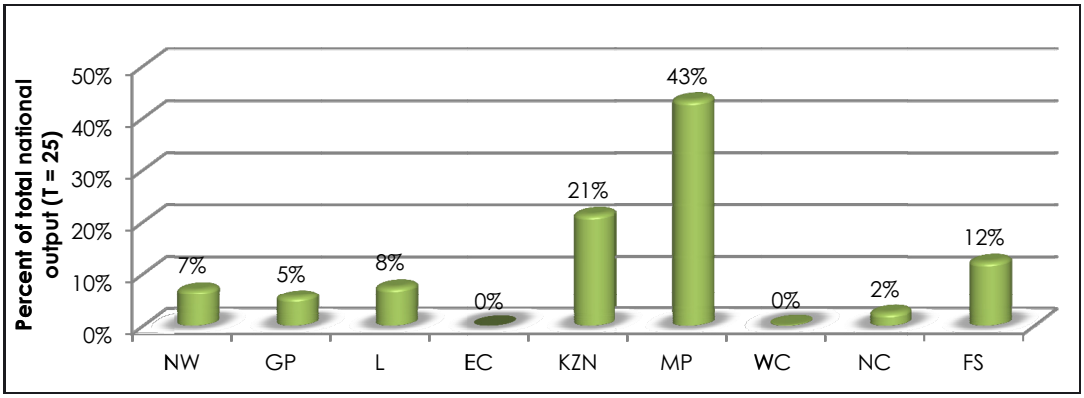

Fig. 5. Soybean output per province as a per cent of national crop in South Africa. Source: Authors own calculations data using data from the CEC, DAFF.

Table 3. Probability score of output province by province in South Africa (T = 25).

P (y > x)	North West	Gauteng	Limpopo	EC	KZN	MP	WC	NC	FS
NW		**0.72***	0.44	**1.00***	0	0	**1.00***	**0.84***	0.32
GP	0.28		0.36	**1.00***	0	0	**1.00***	**0.92***	0.20
L	**0.66****	0.04		0.04	0.04	0	0	0	0.04
EC	0	0	0		0	0	0.24	0.08	0
KZN	**1.00***	**1.00***	**1.00***	**1.00***		0	**1.00***	**1.00***	**0.76***
MP	**1.00***	**1.00***	**1.00***	**1.00***	**1.00***		**1.00***	**1.00***	**1.00***
WC	0	0	0	**0.48*****	0	0		0.12	0
NC	0.16	0.08	0.12	**0.92***	0	0	**0.88***		0.12
FS	**0.68****	**0.80***	**0.72***	**1.00***	0.24	0	**1.00***	**0.84***	

*Extremely likely (above 69.5%), ** reasonably likely (54.5–69.4%), *** on the edge (48–54.4%). Source: Authors own calculations using data from National Department of Agriculture.

same periods. Mpumalanga Province (MP) is by far the largest producer of soybeans in South Africa, in terms of output and area planted. KwaZulu Natal province is second, whilst the Free State is third. Figure 2 shows the interaction between rainfall and soybean production in South Africa.

The map illustrates that in terms of rains, Mpumalanga, KZN, and some parts of Gauteng, Eastern Cape and the Free State are suitable for soybean production.

Moreover, since soybeans can also be rotated with maize, the Free State, North West, Gauteng and Limpopo provinces possess a greater potential for soybean production. In the past 25 years, MP has contributed 43% of the average National soybean crop (of 233 398.20 tons/year), followed by KZN with 21%, and the Free State with 12%, respectively, as shown in Figure 5. Soybean production in these three provinces accounted for 76% of total soybean output in South Africa in the past 25 years.

3.1 Production probabilities

Table 3 shows the probability scores of output being higher in one province (y) when compared to output in another province (x) over the past 25 years. Taking row one, the probability that output in North West (NW) province (y) will be higher than output in Gauteng (GP), Limpopo (L), Eastern Cape (EC), Western Cape (WC), Northern Cape (NC) and the Free State (FS) excluding Mpumalanga (MP) and KwaZulu Natal (KZN) provinces (x's) is 0.72, 0.44, 1.00, 1.00, 0.84 and 0.32, respectively.

Faced with a decision of where to produce between NW province and GP, the probability score reveals that a farmer has a 0.72 or 72% chance of obtaining a higher output in NW than in Gauteng; a 44% probability of success in Limpopo, a 100% chance over EC and WC; an 84% likelihood of success over NC; and a 32% chance of success over the Free State Province. In other words, a farmer is most likely to get higher output in North West than in Gauteng, Northern Cape, Western Cape and Eastern Cape provinces, respectively. If the probability is below 0.5 or 50%, the implication is that the opposite is true – meaning that a farmer is most likely to get higher output in province (x). Hence, confronted with having to make a decision of where to produce between NW and, Limpopo and, the Free State province, for example, the probability scores reveal that the farmer should ideally chose the Free State province because it has the lowest probability score (32%), compared with 68% for the Free State over North West. This is also true for Limpopo province which has a 56% chance of getting higher output compared with 44% for North West over Limpopo.

The remainder of the probabilities in the rows show, for example, that in the past 25 years, MP had a 100% chance of getting an output higher than any province, followed by

Table 4. An illustration of provincial growth in soybean production in South Africa as a proportion of national output, 1987 to 2012.

National		Provincial								
		FS	NW	GP	MP	WC	EC	KZN	NC	L
Area planted (ha)										
Average growth rate										
25 yrave	145 635.59	0.15***	0.06	0.06	0.49*	0.00	0.00	0.17**	0.02	0.05
15 yrave	201 392.67	0.19**	0.05	0.03	0.53*	0.00	0.00	0.14***	0.00	0.05
10 yrave	241 330.00	0.24**	0.05	0.03	0.51*	0.00	0.00	0.11*	0.00	0.05
5 yrave	320 920.00	0.30**	0.04	0.03	0.47*	–	0.00	0.09*	0.00	0.05
Compounded annual growth rate (CAGR)										
CAGR 25	0.11	0.04***	−0.04***	−0.04***	0.01	−1.00	0.00	−0.05**	−0.12*	0.00
CAGR 15	0.10	0.17*	−0.02	0.00	−0.02	–	0.00	−0.08***	−0.11**	0.03
CAGR 10	0.19	0.10*	0.09*	0.00	−0.04	−1.00	0.04	−0.07**	0.00	−0.01
CAGR 5	0.30	0.06	0.05	0.18**	−0.04	–	−0.09***	−0.09***	−0.23*	0.01
Output (tons)										
Average growth rate										
25 yrave	233 398.20	0.12***	0.07	0.05	0.43*	0.00	0.00	0.21**	0.02	0.08
15 yrave	333 277.00	0.16***	0.07	0.03	0.46*	0.00	0.00	0.19**	0.00	0.08
10 yrave	398 202.00	0.20**	0.07	0.03	0.46*	0.00	0.00	0.15***	0.00	0.09
5 yrave	544 800.00	0.25**	0.05	0.03	0.44*	–	0.00	0.14*	0.00	0.08
Compounded annual growth rate (CAGR)										
CAGR 25	0.09	0.04	−0.04**	−0.03***	0.01	−1.00	0.00	−0.03***	−0.11*	0.02
CAGR 15	0.08	0.14*	−0.04	0.02	−0.01	0.00	0.00	−0.06***	−0.13**	0.03
CAGR 10	0.19	0.10*	0.03**	0.00	−0.03**	−1.00	−0.01***	−0.03**	0.00	−0.03**
CAGR 5	0.23	0.07**	−0.02	0.22*	−0.03	0.00	−0.10	−0.05***	−0.22*	−0.01
Yield (t/ha)										
Average growth rate										
25 yrave	1.56	0.88	1.3	0.94	0.91	0.4	0.5	1.29***	1.56*	1.47**
15 yrave	1.66	0.83	1.43***	0.95	0.88	0.42	0.91	1.39	1.50**	1.65*
10 yrave	1.65	0.82	1.5***	0.95	0.90	0.5	1.2	1.45	1.65*	1.58**
5 yrave	1.75	0.82	1.4	0.95	0.93	–	1.0	1.49***	1.81*	1.54**
Compounded annual growth rate (CAGR)										
CAGR 25	−0.00	0.00***	0.01**	0.01**	−0.01**	−1.00	0.00	0.02*	0.01**	0.02*
CAGR 15	−0.00	−0.03*	−0.02**	0.02**	0.01***	0.00	0.00	0.02**	−0.02**	0.00
CAGR 10	0.99	−0.01	−0.05*	0.00	0.01	−1.00	−0.05*	0.04**	0.00	– 0.02***
CAGR 5	0.04	0.00	−0.07*	0.04**	0.01	0.00	−0.02***	0.04**	0.01	−0.01

Note that FS = Free State, NW = North West, GP = Gauteng, MP = Mpumalanga, WC = Western Cape, EC = Eastern Cape, KZN = KwaZulu Natal, NC = Northern Cape, L = Limpopo provinces, respectively. * Highest; ** moderate; *** low (used absolute values, sign used to denote direction of growth). Source: Author's own calculations using data from the DAFF (2013).

KZN, and lastly the Free State Province. The Eastern Cape and the Western Cape showed a high probability of yielding lower output than any other province. Moreover, it should be noted that based on Figure 2, the Eastern Cape province possesses a good chance of being a soybean producing province. However, because agricultural production falls in the hands of smallholder farmers, there is still a lot of farmer development that needs to be done before the province can emerge as a stable producer of soybeans.

Table 3 illustrates that in cases where the Western Cape province produced soybeans, the probability that the output therein would be higher than in the Eastern Cape was 48% whereas the probability that output in the Eastern Cape would be higher than in the Western Cape was low at 24%. Worth noting is that: the original dataset from the Crop Estimation Committee in the DAFF (2013) shows that currently there is no significant production of soybeans in the Western Cape whereas 500ha were used for the production of soybeans in the Eastern Cape Province, in 2012. Even though the Eastern Cape Province started producing soybeans in 2000, the area planted has decreased (negative CAGR) by 9% over the past 5 years, compared to a CAGR of 4% between 2003 and 2012, as shown in Table 4, suggesting an unstable soybean production regime in the province.

The proportion of area planted, output and yield obtained in the provinces, respectively, as a percentage of national figures is shown in Table 4. In the past 25 years, area planted to soybeans in South Africa increased by an average

of 145 635.59 ha with a CAGR of 9%, at national level. Of this, Mpumalanga accounted 49%, followed by KZN with 17% and the Free State with 15% of national output. However, the CAGR suggests that the highest growth in area planted actually took place in the Free State province, which had a CAGR of 4%, whereas the Northern Cape province experienced the highest decrease (–12%) in area planted to soybeans in the past 25 years. Gauteng province experienced the largest growth in area planted to soybeans and in terms of output in the past 5 years. The incidence of drought in the Northern Cape cannot be ruled out as a major cause of a decline in production whereas improved understanding of soybean production, including the availability of generally easy to plant and manage Roundup® Ready soybean cultivars could have been responsible for the increase in area planted in the Free State and Gauteng provinces, respectively.

In general, Mpumalanga province has had the highest average growth rates for area planted, decreasing slightly in the past 5 years when compared with the 25 years' average. The province's 15 years average is also highest when compared with the other provincial averages. This suggests that as of 1997, more land was without doubt brought into soybean production in Mpumalanga. This is further confirmed by the CAGR for land underproduction which was 1% for the period 1987 to 2012. As well, in the past 5 to 15 years, Mpumalanga experienced a decrease (negative CAGR) in area planted to soybeans. Between 1997 and 2012, land under soybean production decreased by 2%; whereas between 2001 and 2012 it decreased by 4%, in Mpumalanga. In the past 5 years (2008 to 2012) Mpumalanga has lost about 4% of land previously allocated to soybeans in 2008. Table 3 further shows that the highest changes in land under soybean production occurred post 1997 in all the provinces.

Even though Mpumalanga remains the leading soybean producing province, output has somewhat decreased in the short term, owing to a decrease in area planted. In the past 5 years, average output decreased by 2% to 44% of national output from an average of 46% in the past 10 years. Whereas the Free State has seen improvements in output, Mpumalanga and Kwa-Zulu Natal provinces have been experiencing the exact opposite. In detail, the CAGR of output shows that output in the Free State grew by 7% in the past 5 years. In contrast Gauteng had the highest CAGR in the past 5 years, which is perhaps because output was quite low in 2008. In terms of yield gains, the results show that KZN and Gauteng have been doing well in the past 25 years. As well, the Northern Cape province has had the highest yields in comparison to the national average over the past 5 years, reaching 1.81 tons/ha against an average of 1.75 tons/ha at national.

4 Discussion

From the preceding sections, it is evident that the production of soybeans in South Africa is growing and will continue to grow in the long term. The analysis of output reveals that whilst South African farmers have increased the area under production, the average yield per hectare at national level has to some degree remained relatively lower than experimental yields. Remarkably, however, is that after 1997/8 farming season onwards, output and land under production increased quite substantially, averaging 117% and 2t/ha, respectively. In contrast, from 1976 to 2012, area planted grew at an average growth rate of 112% whilst output averaged 1.29 t/ha. This is because; in 1997 the government of South Africa enacted the GMO Act, which allows the development, commercialisation and production of transgenic seeds in South Africa. This Act has made it easier for farmers to use the latest agricultural technologies in the market, especially Roundup® ready seed. As a result, between 1997/8 and 2012, the CAGR of land underproduction increased by 10%. Output, on the other hand, had a CAGR of 8% suggesting that there have been considerable gains in production output post the GMO Act of 1997. In contrast, output from 1976 to 2012, reveals a CAGR of 9% against a CAGR of 23% in the past 5 years, suggesting that considerable gains in output occurred in the past 5 years.

Using seed sales data the paper illustrates that because seed companies have managed to develop locality specific soybean cultivars, farmers have responded by increasing the area under soybeans production. This is in spite of the finding that farmer average yields per hectare are still yet to match experimental yields, in terms of the possibility of higher yields than present. Soybean cultivars often show a higher yield potential in the Soybean National Cultivar trials conducted by the Agricultural research council (ARC), suggesting that there is room for further growth. The analysis revealed that as South African farmers were increasing the area under soybean production, they correspondingly acquired a better understanding of how to optimise soybean production in the various bio-environments in the different provinces. The availability of adaptable and insect pests and diseases resistant cultivars has also contributed in increasing the appeal for the crop, which has necessitated farmers to incorporate sophisticated production practices. Due to inaccessibility of seed sales data before 2004/5, it is difficult to estimate growth in the adoption of transgenic soybean cultivars in South Africa. However, from 2004/5 onwards, the data reveals that the proportion of farm saved seed as a percentage of the potential local seed market was considerably high, ranging from 65% in 2004/5 to 85% in 2007/8. The high proportion of farm saved seed signifies that there may be a high usage of farm saved seed amongst soybean farmers in South Africa which may be driven by conventional seeds which are in high demand in neighbouring as a source of input in the manufacture of human food, especially corn soy blend.

Although the South African seed industry is characterised by well-known seed companies[2], market share quantification is difficult given the secrecy attached to such information. Yet, the growth in soybean seed sales, suggest a vibrant industry that has an even bigger potential in the future, given the importance of quality seed in crop production. The data

[2] These companies have been quantified using the Soybean National Cultivar Trials reports, which are produced by the ARC-Grain Crops Institute, in South Africa. In 2012, they included Pannar, Pioneer, Link Seed and ALLGRO, in no particular order. Information on market share is considered confidential. Worth noting is that seed sales in South Africa requires that agents adhere to the provisions of the Plant Protection Act of 1976, as amended. Seed must be registered in the varietal list and should be tested in the National Cultivar Trials.

for seed sales relates to all seed sold to commercial and smallholder farmers. Even though there are programmes in place to ensure that smallholder farmers are involved in the production of soybeans, currently, there is no data to quantify the production status in this sector. By and large, however, it is clear that because smallholder farmers do not have immediate uses for the crop, it is still going to take some time before they start producing the crop. Many organisations and writers in South Africa, including the industrial policy action plan of 2010, have reiterated the need to develop soybean based food so as to entice South African households to see the food value of soybeans.

5 Conclusions

In this paper, the production of soybeans in South Africa was analysed, using basic averages, compounded average growth rate and a probability plot. Soybeans are an important crop in South Africa and the SADC region and their production will continue to grow in the future. However, soybeans are mainly used as animal feed. Oil and direct human consumption constitutes a very small portion of the diets of South African households. Where soybeans are consumed, it is in isolated cases, such as through soups and other nutritious mixtures and soy milk products. Unlike maize or dry beans, South Africans seldom eat soybeans directly. In this paper, it was argued that this emanates from the fact that the crop remained relatively unknown to rural households for a very long time, post its initial introduction to South Africa. Given that thousands of people live in poor, and rural, areas where they face malnutrition due to rising food prices, there is a case to base the assertion that the incorporation of soybean based foods that are economical into household diets will contribute to hunger reduction and increase food security in these areas. The Dti has made provisions to ensure that soybean based foods are developed to South Africa. As well, similar commitments which include promoting the production of soybeans in the rural sector have been made elsewhere in South Africa. However, it should be kept in mind that the ultimate determining factor will likely be the opportunity cost of producing soybeans, its productivity and tangible food security benefits for subsistence households than just policy support. Because soybeans are relatively unknown in South Africa's rural areas, it is unlikely that rural households will respond faster to the government's call to increase soybean production, precisely because there is very little in it for them, if they do not see the food value of the crop.

In terms of production, Mpumalanga remains the leading producer of soybeans in South Africa, followed by KwaZulu Natal, and the Free State Provinces, respectively. The Northern Cape province was found to have attained the highest soybean yields compared to other provinces in the past 25 years – with average yields similar to the national average of 1.56 t/ha. However, the province also experienced the highest decline in land under soybean production in the past 5 years, suggesting that planting plans have been affected by the recurring droughts in the province especially in the past five years. Whereas Mpumalanga is the leading producer of soybeans, the Gauteng Province experienced the largest growth in land under soybean production in the past 5 years. Regrettably, however, is that in spite of the potential that the former homelands have towards soybean production, there is little progress. In order to improve production and consumption of soybeans in these areas, it may help to set up soybean out grower schemes, which will help farmers, pool their output to increase their market, share and ensure steady supply. Since these farmers are riddled by lack of resources, the UNICEF/WFP could help by granting these farmers preferential market access. In so doing, the households could earn income from soybeans whilst learning the food value of the crop, through the many initiatives that are meant to sensitise them to the food value of soybeans.

From a commercial point of view and considering that the BFAP (2013) projects a bright future for the crop in terms of its marketability, it is possible that smallholder farmers may be drawn by the lure of profits into soybean production. Opperman and Varia (2011) have identified the growing demand of soybean based food stuffs in Southern Africa, of which South Africa is no exception. Suffice to say that if the outlook as depicted by the BFAP (2013) does not change, it is likely that by the end of the next 10 years, more smallholder farmers will be producing soybeans in South Africa and that more households would have incorporated soybeans into their daily diets. Yet, all this will depend very much on the success of programmes geared towards developing soybean based foods that will be in line with the diets of people in the majority of South African households. For now, it is probable that the livestock sector, especially poultry, pork and beef, shall continue to drive the demand for soybeans in South Africa. Most of the increase in demand is likely to originate from the poultry sector given existing efforts to revive the industry and make it more competitive both locally and internationally. Currently, South Africa imports a large quantity of processed poultry products from Brazil and pork products from the European Union, mainly France, Germany and Spain. Increasing local production of poultry and pork is likely to increase the demand for soybeans in South Africa.

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